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HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

Information on the type approval of the BALWAT Ballast Water Management System

Submitted by China

SUMMARY

Executive summary:	This document provides information on the type approval of the BALWAT Ballast Water Management System manufactured by Shanghai Jiazhou Environmental Mechanical & Electrical Co. Ltd.
Strategic direction:	7.1 and 13
High-level action:	7.1.2 and 13.0.3
Planned output:	7.1.2.4 and 13.0.3.1
Action to be taken:	Paragraph 6
Related documents:	MEPC 59/24 and resolution MEPC.228(65)

Introduction

1 Regulation D-3.1 of the International Convention for the Control and Management of Ship's Ballast Water and Sediments, 2004, stipulates that ballast water management systems (BWMS) must be approved by the Administration taking into account guidelines developed by the Organization.

2 According to the clarification made at MEPC 59, it is for the National Administration to determine if a ballast water management system that uses UV light produces Active Substances and to decide whether it needs to make a proposal for approval to the Committee or not. The China Maritime Safety Administration (China MSA) reviewed the technical specification of the BALWAT BWMS, approved the technologies applied in the system, which do not use or produce Active Substances, and verified the application dossier submitted by the Shanghai Jiazhou Environmental Mechanical & Electrical Co. Ltd. It is believed that the system satisfies the provisions of the *Guidelines for approval of ballast water management systems (G8)*.

3 The plan approval process was reviewed by the China Classification Society (CCS) on behalf of China MSA. All the land-based and shipboard tests contained in the Guidelines (G8) were conducted by the Ballast Water Detecting Laboratory of Shanghai Ocean University. The environmental tests were conducted by the Marine Engineering and Reliability Laboratory of Number 704 Research Institute of China Shipbuilding Industry Corporation.

4 On the basis of the above, a Type Approval Certificate was issued on 5 February 2013 to the BALWAT BWMS for the treatment rated capacity of 200 m^3/h by the China Classification Society under the authority of China MSA. A copy of the Certificate is contained in annex 1 to this document.

5 In accordance with resolution MEPC.228(65) on *Information reporting on type approved ballast water management systems*, the following information is provided:

.1 approval date: 5 February 2013;

.2 name of the Administration: China Maritime Safety Administration;

.3 name of the BWMS: BALWAT Ballast Water Management System;

.4 a copy of the Type Approval Certificate is provided in annex 1 and details on all imposed limiting conditions on the operation of the BWMS can be found in annex 2 to this document;

.5 a summary of the test results of the land-based and shipboard test run has been included in annex 3 to this document;

.6 details on the protocol can be found in annex 4 to this document;

.7 description of the Active Substances: no use of Active Substances.

Action requested of the Committee

6 The Committee is invited to note the information contained in this document.

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ANNEX 1

TYPE APPROVAL CERTICATE OF THE BALWAT BALLAST WATER MANAGEMENT SYSTEM

格式
Form CP184

中 国 船 级 社
CHINA CLASSIFICATION SOCIETY

编号
No. SH11T00198_02

压载水管理系统型式认可证书

TYPE APPROVAL CERTIFICATE OF BALLAST WATER MANAGEMENT SYSTEM

兹证明，下述压载水管理系统已经根据IMO的MEPC.174(58)决议中导则的相关规范要求通过了检验和测试。本证书仅对下述提及的压载水管理系统有效。

This is to certify that the ballast water management system listed below has been examined and tested in accordance with the requirements of the specifications contained in the Guidelines contained in IMO resolution MEPC.174(58). This certificate is valid only for the ballast water management system referred to below.

压载水管理系统供应方
Ballast water management system supplied by 上海嘉洲环保机电设备有限责任公司 Shanghai Jiazhou Environmental Mechanical&Electrical Co.,Ltd

指定类型和型号
under type and model designation BALWAT-200

并包括：
and incorporating:

压载水管理系统制造商
Ballast water management system manufactured by 上海嘉洲环保机电设备有限责任公司 Shanghai Jiazhou Environmental Mechnical&Electrical Co.,Ltd

设备/组件图号 日期
to equipment/assembly drawing No. 321JZ-114-00 date 2012-12-17

其它设备制造商
Other equipment manufactured by

设备/组件图号 日期
to equipment/assembly drawing No. date

CCS

No. 13708009

额定处理能力

Treatment rated capacity 200 m^3 /h

本型式认可证书的副本应始终保留在安装该压载水管理系统的船舶上。船上检查时，应提供测试方案的参考文件和测试结果的复印件。如果型式认可证书是基于另一主管机关已经授予的认可签发，则应注明所依据的型式认可证书。

A copy of this Type Approval Certificate, should be carried on board a vessel fitted with this ballast water management system at all times. A reference to the test protocol and a copy of the test results should be available for inspection on board the vessel.If the Type Approval Certificate is issued based on approval by another Administration,reference to that Type Approval Certificate shall be made.

限制条件的说明见本文件的附件。

Limiting Conditions imposed are described in the appendix to this document.

公章

Official stamp

签字

Signed (Liu Ming)

中 国 船 级 社

China Classification Society

日期

Dated 2013-02-05

附件：原始测试结果的副本

Enc. Copy of the original test results.

№ 14284940

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ANNEX 2

DETAILS ON ALL IMPOSED LIMITING CONDITIONS ON THE OPERATION OF THE BWMS

Environmental Conditions	Salinity	No requirements for this equipment, appropriate for all seawater salinity.
	UV Transmittance	The UV transmittance of the equipment itself is 85%, which means it may satisfy the expected requirements of inactivated marine organisms when the tube ages to 85% output intensity.
	Temperature	sea water temperature: ≥ 0°C environmental temperature: 0 – 55°C
	Humidity	≤ 95% (at 55°C)
	Inclination	± 22.5°
	Swaying	± 22.5°
Operation Parameters of the System	Maximum operating pressure	1 MPa
	Minimum operating pressure	0.15 MPa
	Maximum pressure differential	0.1 MPa
	TRO	The treatment process of this equipment is of pure physical, without any addition or production of materials of oxidation, the TRO of discharge water is 0 mg/L.

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ANNEX 3

SUMMARY OF THE TEST RESULTS OF THE LAND-BASED AND SHIPBOARD TEST RUN

General

This document provides a summary of the test results of the land-based and shipboard test runs of the BALWAT BWMS for type approval.

Results from land-based tests

The land-based test of the BALWAT BWMS, researched and developed by the Shanghai Jiazhou Environmental Mechanical & Electrical Co., Ltd., was carried out at the ballast water test site of Jiangchuan Road in Shanghai during the period from December 2011 to March 2012. Compared to the D-2 Standard and the requirements of Guidelines (G8), the results of the test samples are as follows:

.1 in the low-salt serial test in 5-cycle ballast: the average value of the water temperature is 12.68°C, the average value of the salinity is 19.1 PSU, the average value of the particulate organic carbon (POC) is 5.47 mg/L, the average value of the total suspended solids (SS) is 57.66 mg/L, and the average value of the dissolved organic carbon (DOC) is 9.83 mg/L. The high-salt serial test in 5-cycle ballast: the average value of the water temperature is 9.64°C, the average value of the salinity is 32.7 PSU, the average value of the particulate organic carbon (POC) is 2.28 mg/L, the average value of the total suspended solids (SS) is 26.68 mg/L, and the average value of the dissolved organic carbon (DOC) is 9.42 mg/L. The particulate organic carbon (POC), the total suspended solids (SS) and the dissolved organic carbon (DOC) flowing into the ballast water in ten cycles for the two salinity serial tests fully meet the requirements of Guidelines (G8), and the salinities in the two tests differ by at least 10 PSU, which totally conforms to the requirements of Guidelines (G8);

.2 organisms greater than or equal to 50 µm in ten land-based cycles are additional. The densities of organisms flowing into the ballast water greater than or equal to 50 µm in low and high salinities are separately $1.98x10^5$ ind./m3 and $2.03x10^5$ ind./m^3, which are composed of five kinds of Arthropoda, Protozoa and Rotifero. The main species are brine shrimp, *Euplotes* sp., *Difflugia* sp., *Harpacticoida* sp. and *Brachionus* sp., etc; among which the brine shrimp is the dominant species. Both of the taxonomy and the biodensity meet the requirements of Guidelines (G8). After five days with UV, when the discharge water is at least 50 µm, the biodensity in the low-salt treatment cabin is 0.73 ind./m^3, comparing to the biodensity $2.08x10^4$ ind./m^3 with discharge water ≥ 50µm. After five days with UV, the biodensity with discharge water ≥ 50µm in the high-salt treatment cabin is 1.53 ind./m^3, comparing to the biodensity $1.83x10^4$ ind./m^3 with discharge water ≥ 50µm. Both of them comply with the discharge standards of Guidelines (G8) and regulation D-2;

.3 organisms of between 10 and 50 µm in the land-based test are additional, comprising algae Chlorophyta, Pyrrophyta, and Bacillariophyta, mainly including *Platymonas helgolandica var.tsingtaoensis, Pyramimimonas* sp., *Platymonas* sp., *Prorocentrum minimum*, *Amphora coffeaeformis*, and

Nitzschia frustulum, etc; among which the *Platymonas helgolandica var.tsingtaoensis* and *Platymonas* sp. are the dominant species. The densities of organisms flowing into the ballast water among 10 to 50 µm in low and high salt sets are separately $2.85x10^3$ cells/mL and $2.43x10^3$ cells/mL. Both of the taxonomy and the biodensity meet the requirements of Guidelines (G8). After five days with UV, the biodensity with discharge water among 10 to 50 µm in the low-salt treatment cabin is 1.6 cells/mL, comparing to the biodensity $2.51x10^2$ cells/mL with discharge water among 10 to 50 µm. After five days with UV, the biodensity with discharge water among 10 to 50 µm in the high-salt treatment cabin is 0.93 cells/mL, comparing to the biodensity $2.39x10^2$ cells/mL with discharge water among 10 to 50 µm. Both of them meet the D-2 standard and the requirements of Guidelines (G8);

.4 make the quantity of the microorganism flowing into the ballast water comply with the requirements of Guidelines (G8) with artificially delivering *Escherichia coli*. The total quantity of the inflow heterotrophy is above $4.93x10^5$/mL, and the biodensity meets the requirements of Guidelines (G8). After five days with UV, the total concentration of the discharge water heterotrophy in the low-salt serial cycle treatment cabin is about 1.4/mL, comparing to the total concentration $4.95x10^4$ /mL of the discharge water heterotrophy. After five days with UV, the total concentration of the discharge water heterotrophy in the high-salt serial cycle treatment cabin is 1.73/mL, comparing to the total concentration $4.53x10^4$/mL of the discharge water heterotrophy; and

.5 After five days with UV, the concentration of the *Escherichia coli* in discharge water in low-salt cycle treatment cabin is less than 2 cfu/100mL, comparing to $2.74x10^4$ cfu/100mL the average concentration of the *Escherichia coli* in discharge water. After five days with UV, the concentration of the *Escherichia coli* in discharge water in high-salt cycle treatment cabin is less than 2 cfu/100mL, comparing to $2.44x10^4$ cfu/100mL the average concentration of the *Escherichia coli* in discharge water. Both of the two meet the requirements of Guidelines (G8) and the D-2 standard. Enterococcus and *Vibrio cholera* are not detected in the ten cycles of the land-based test. According to the results analysis on the four microorganisms indicators, they completely accord with the D-2 standard and the requirements of Guidelines (G8).

In conclusion, indicators flowing into ballast water in ten land-based cycles and indicators of the discharge water in the control cabin are all in accordance with the requirements of Guidelines (G8), and the indicators of the discharge water in the treatment cabin also conform to the D-2 standard as well as the requirements of Guidelines (G8).

Table 1: Record list of flow and UV light intensity of the land-based test

Cycle No.	Item	Ballast in treatment cabin	Ballast in control cabin	Discharge in treatment cabin	Discharge in control cabin
1	Flow (m^3/h)	199	198	198	197
	Light Intensity ($\mu W/cm^2$)	7906	/	7912	/
2	Flow (m^3/h)	201	200	200	199
	Light Intensity ($\mu W/cm^2$)	7921	/	7945	/
3	Flow (m^3/h)	196	201	197	198
	Light Intensity ($\mu W/cm^2$)	7950	/	7945	/
4	Flow (m^3/h)	197	198	198	197
	Light Intensity ($\mu W/cm^2$)	7920	/	7920	/
5	Flow (m^3/h)	199	200	198	197
	Light Intensity ($\mu W/cm^2$)	7920	/	7920	/
6	Flow (m^3/h)	201	199	198	201
	Light Intensity ($\mu W/cm^2$)	7920	/	7900	/
7	Flow (m^3/h)	196	201	201	199
	Light Intensity ($\mu W/cm^2$)	7900	/	7900	/
8	Flow (m^3/h)	197	199	200	201
	Light Intensity ($\mu W/cm^2$)	7850	/	7950	/
9	Flow (m^3/h)	199	200	200	200
	Light Intensity ($\mu W/cm^2$)	7900	/	7900	/
10	Flow (m^3/h)	200	201	200	200
	Light Intensity ($\mu W/cm^2$)	7900	/	7900	/

Table 2: Parameters measurement results of water quality of the land-based test

Items	Unit	Average	Minimum	Maximum	IMO requirement
Salinity > 32 PSU					
Temperature	°C	9.64	9.00	10.80	-
Salinity	PSU	32.7	32.2	33.2	> 32
Turbidity	°	10.45	9.04	12.17	-
TSS	mg/L	26.68	22.50	29.10	> 1
DO	mg/L	9.03	5.47	10.11	-
PH	-	8.00	7.95	8.14	-
POC	mg/L	2.28	2.17	2.47	> 1
DOC	mg/L	9.42	7.92	11.10	> 1
TRO	mg/L	ND	ND	ND	-
Salinity 3-32 PSU					
Temperature	°C	12.68	11.00	15.10	-
Salinity	PSU	19.1	18.4	19.9	3-32
Turbidity	°	21.78	20.87	23.96	-
TSS	mg/L	57.66	55.80	60.10	> 50
DO	mg/L	8.48	6.18	9.36	-
PH	-	7.91	7.83	7.93	-
POC	mg/L	5.47	5.28	5.87	> 5
DOC	mg/L	9.83	8.05	15.50	> 5
TRO	mg/L	ND	ND	ND	-

Table 3: Measurement results of active organisms and bacterias of the land-based test

Salinity	Parameter	IMO standard (G8 D-2)			Test result		
		Influent water	Control water	Treated water	Influent water	Control water	Treat water
> 32 PSU	≥ 50 µm (ind./m³)	> 10^5	> 100	< 10	2.03x10^5	1.83x10^4	1.53
	10-50 µm (cells/mL)	> 10^3	> 100	< 10	2.43x10^3	2.39x10^2	0.93
	Heterotroph (num/mL)	> 10^4	N/A	-	5.86x10^5	4.53x10^4	1.73
	Escherichia coli (cfu/100mL)	N/A	N/A	< 250	4.25x10^6	2.44x10^4	< 2
	Intestinal Enterococcus (cfu/100mL)	N/A	N/A	<100	ND	ND	ND
	Vibrio cholerae (cfu/100mL)	N/A	N/A	< 1	ND	ND	ND
3-32 PSU	≥ 50 µm (ind./m³)	> 10^5	> 100	< 10	1.98x10^5	2.08x10^4	0.73
	10-50 µm (cells/mL)	> 10^3	> 100	< 10	2.85x10^3	2.51x10^2	1.6
	Heterotroph (num/mL)	> 10^4	N/A	-	6.09x10^5	4.95x10^4	1.4
	Escherichia coli (cfu/100mL)	N/A	N/A	< 250	3.93x10^6	2.74x10^4	< 2
	Intestinal Enterococcus (cfu/100mL)	N/A	N/A	<100	ND	ND	ND
	Vibrio cholerae (cfu/100mL)	N/A	N/A	<1	ND	ND	ND

Results from shipboard tests

The BALWAT Ballast Water Management System, which was developed by Shanghai Jiazhou Environmental Mechanical & Electrical Co., Ltd., was thrice shipboard tested on Baoying Sea No.1 cargo ship for the duration of 192 days. The test was carried out according to the time requirements of Guidelines (G8). With comparison of the test results with Guidelines (G8) and the D-2 standard, the conclusions are as follows:

.1 in the three cycles of the shipboard test, the densities of organisms greater than or equal to 50 µm of ballast water inflow were between 1.05x10^2 and 1.76x10^2 ind./m³, averaged 1.46x10^2 ind./m³, which accorded with Guidelines (G8). During the discharge, the average biodensities of the treatment cabin of the three cycles were separately 1.22 ind./m³, 0.67 ind./m³ and 2 ind./m³, while the discharge in the control cabin were separately 146 ind./m³, 77 ind./m³ and 114 ind./m³. The discharge standards were all met during the treatment cabin discharge, and the requirements of Guidelines (G8) were completely met during the discharge in the control cabin;

.2 during three cycles of the shipboard tests, the biodensities were between 1.21x10^2 and 3.01x10^2 cells/mL, averaged 2.11x10^2 cells/mL, which accorded with Guidelines (G8). During the treatment cabin discharge, the average active biodensities were separately 1.67 cells/mL, 1.2 cells/mL

and 1 cells/mL, while the discharge in the control cabin were separately 199 cells/mL, 190 cells/mL and 116 cells/mL. The D-2 standard was met for the organisms between 10 and 50 µm of the treatment cabin discharge, and the requirements of Guidelines (G8) were completely met during the discharge in the control cabin; and

.3 In the shipboard test, the total amount of heterotroph in the ballast water cycle inflow reached $2.2x10^4$ num./mL, $3.4x10^5$ num./mL and $7.2x10^7$ num./mL, the average densities of heterotroph of discharge water in treatment cabin were separately 3.8 num./mL, 3.6 num./mL and 5.9 num./mL, which accorded with Guidelines (G8). The average densities of *Escherichia coli* of the inflow ballast water during the cycles were between $1.5x10^3$ and $5.4x10^4$ cfu/100mL, the *Escherichia coli* average densities of the treatment cabin discharge water were separately 0.6 cfu/100 mL, 3.0 cfu/100 mL and 0.8 cfu/100 mL, while the *Escherichia coli* average densities of the control cabin discharge water were separately 880 cfu/100 mL, $1.3x10^4$ cfu/100 mL and 190 cfu/100 mL, which accorded with Guidelines (G8) and the D-2 standard. The Enterococcus and *Vibrio* were not detected in ballast water of all three shipboard tests.

With the shipboard test results of the BALWAT Ballast Water Management System, the biocidally active effects of the system on each droplet size organism shall meet the requirements of Guidelines (G8) and the D-2 standard.

Table 4: Record list of flow and UV light intensity of the land-based test

Cycle No.	Item	Ballast in treatment cabin	Ballast in control cabin	Discharge in treatment cabin	Discharge in control cabin
1	Flow (m3/h)	195	195	195	198
	Light Intensity (µW/cm2)	7915	/	7906	/
2	Flow (m3/h)	194	193	197	198
	Light Intensity (µW/cm2)	7912	/	7900	/
3	Flow (m3/h)	196	198	194	198
	Light Intensity (µW/cm2)	7915	/	7909	/

Table 5: Parameters measurement results of water quality of the shipboard test

Cycle No.	Items	Unit	Average
1	Temperature	°C	13.3
	Salinity	PSU	0.2
	TSS	mg/L	24.91
	POC	mg/L	0.13
2	Temperature	°C	29.6
	Salinity	PSU	3.6
	TSS	mg/L	28.25
	POC	mg/L	0.18
3	Temperature	°C	27.5
	Salinity	PSU	28.6
	TSS	mg/L	10.98
	POC	mg/L	0.19

Table 6: Measurement results of active organisms and bacterias of the shipboard test

Cycle No.	Parameter	IMO standard(G8 D-2)			Test result		
		Influent water	Control water	Treated water	Influent water	Control water	Treat water
1	≥ 50 μm (ind./m³)	> 100	> 10	< 10	$1.75x10^2$	146	1.22
	10 – 50 μm(cells/mL)	> 100	> 10	< 10	$2.20x10^2$	199	1.67
	Heterotroph (num/mL)	N/A	N/A	-	$2.2x10^4$	$2.2x10^3$	3.8
	Escherichia coli (cfu /100mL)	N/A	N/A	< 250	$1.5x10^3$	880	0.6
	Intestinal Enterococcus (cfu/100mL)	N/A	N/A	< 100	ND	ND	ND
	Vibrio cholerae (cfu/100mL)	N/A	N/A	< 1	ND	ND	ND
2	≥ 50 μm (ind./m³)	> 100	> 10	< 10	$1.19x10^2$	77	0.67
	10 – 50 μm (cells/mL)	> 100	> 10	< 10	$2.77x10^2$	190	1.2
	Heterotroph (num/mL)	N/A	N/A	-	$3.4x10^5$	$2.1x10^5$	3.6
	Escherichia coli (cfu/100mL)	N/A	N/A	< 250	$4.4x10^4$	$1.3x10^4$	3
	Intestinal Enterococcus (cfu/100mL)	N/A	N/A	< 100	ND	ND	ND
	Vibrio cholerae (cfu/100mL)	N/A	N/A	< 1	ND	ND	ND
3	≥ 50 μm (ind./m³)	> 100	> 10	< 10	$1.43x10^2$	114	2
	10 – 50 μm (cells/mL)	> 100	> 10	< 10	$1.35x10^2$	116	1
	Heterotroph (num/mL)	N/A	N/A	-	$7.2x10^7$	$8.1x10^5$	5.9
	Escherichia coli (cfu/100mL)	N/A	N/A	< 250	2.9×10^3	190	0.8
	Intestinal Enterococcus (cfu/100mL)	N/A	N/A	< 100	ND	ND	ND
	Vibrio cholerae (cfu/100mL)	N/A	N/A	< 1	ND	ND	ND

ANNEX 4

DETAILS ON THE PROTOCOL

Details on the protocol of the land-based tests

.1 The land-based test was carried out at the test site (Jiangchuan Road) of the Shanghai Jiazhou Environmental Mechanical & Electrical Co., Ltd. Because of test site lays inland, cultured microorganisms, concentrated seawater and freshwater-based simulated seawater were used in the test. Information of the cultured microorganisms is as follows:

.1 microorganisms were composed of five kinds of Arthropoda, Protozoa and Rotifero. The main species are brine shrimp, *Euplotes* sp., *Difflugia* sp., *Harpacticoida* sp. and *Brachionus* sp., etc, among which the brine shrimp is the dominant species. Organisms of 10 to 50 μm in the land-based test are additional, comprising algae Chlorophyta, Pyrrophyta, and Bacillariophyta, mainly including *Platymonas helgolandica var.tsingtaoensis*, *Pyramimimonas* sp., *Platymonas* sp., *Prorocentrum minimum*, *Amphora coffeaeformis*, and *Nitzschia frustulum*, etc; among which the *Platymonas helgolandica var.tsingtaoensis* and *Platymonas* sp. are the dominant species.

.2 The BALWAT-200 Type Ballast Water Management System was used in the land-based test, which rated flow was 200 m^3/h and power was 6 kW. The output intensity of the UV light was controlled as the output intensity of UV light at the endpoint of lifetime, defined as 85% of a new light which was approximately 7900 μW/cm^2, and instantaneous flow was 200 ± 10 m^3/h. The rated pressure of the ballast pump was 0.4 MPa.

.3 The ten cycles of land-based test were all successfully effectively operated, without any failure or invalidation.

Details on the protocol of the shipboard tests

.1 The shipboard test was carried out on the Baoying Sea No.1 Cargoship, and natural seawater was used as test water without any addition of organisms.

.2 The BALWAT-200 type Ballast Water Management System was used in the full-scale test, which rated flow was 200 m^3/h and power was 6 kW. The output intensity of the UV light was controlled as the output intensity of UV light at the endpoint of lifetime, defined as 85% of a new light which was approximately 7900 μW/cm^2, and instantaneous flow was 200 ± 10 m^3/h. The rated pressure of the ballast pump was 0.4 MPa.

.3 The three cycles of land-based test were all successfully effectively operated, without any failure or invalidation.

QA/QC documentation

The Ballast Water Testing Laboratory (BWTL) of Shanghai Ocean University, supported and founded by Shanghai Ocean University (SOU) in 2008 September, contains 15 members including four senior professional technical positions. It is divided into four departments,

Sample Reception Room, Water Chemistry Laboratory, Microbiological Testing Room, Microscope Room and Sample Storage Room. The laboratory is dedicated to research on port ecology, mainly including ecology research on plankton in harbour and ship ballast water as well as marine environmental microorganism. The laboratory has gained Certificate issued China National Accreditation Service for Conformity Assessment (CNAS).

.1 Establishment of quality supervision and management system

According to the specific situation of the project, the quality supervision and management system is established; the responsible person and his rights and responsibilities are clarified.

.1 establishment of quality assurance goals

According to the purpose of the survey plan, the requirements for accuracy of analysis results of each factor are determined, as corresponding quality objectives.

.2 definition of task and content of quality assurance

The task of quality assurance is to take effective quality-control measures and reduce the error of element data to required level according to the quality objectives and the error sources of factors.

Content of quality assurance: Equipment verification and training of technical staff; scientific management of field and terrestrial laboratory; sampling and complete analysis process (from sampling to calculation of analysis results) quality control and quality assessment; quality control of data, materials and results.

.2 Quality control

BWTL implements a project quality management program (QMP) in accordance with the "Quality manual", and in accordance with BWTL's program file "Procedures of testing results of quality control", participates in laboratory comparison or laboratory proficiency testing programs conducted by authorized organizations, compares the testing results with authoritative laboratories of the same industry, re-tests the sample within retention period, repeatedly tests the same sample with the same or different methods, and with different or the same instrument and equipment in order to ensure accurate detection results. The test parameters should enjoy high sensitivity, precision, the allowable deviation range and accuracy, to ensure the credibility and integrity of the data. The participants should deserve quality awareness education, and the quality-related responsibilities shall be clearly defined. The quality control of the test process should be integrated into BWTL's quality operation system, and the quality control plan shall be developed on the basis of quality system and testing requirements.

.1 Assurance of field sampling quality control

Sampling and pretreatment related personnel should receive training in accordance with the Guidelines for ballast water sampling (G2) and "GB17378.4-2008" Specification for marine monitoring, then the needs of and requirements for training shall be determined according to "SOU BWTL's personnel training program".

In the project implementation process, the sampling, sample classification and sample treatment shall be strictly implemented in accordance with the prescribed procedures and operation requirements. In field sampling process, a waterproof table shall be adopted to record the collected sample data, including sampling time, sampling operator, weather conditions, environmental conditions, sample number. and sample identification quantity, as well as standard deviation of sample programs or some emergencies. The final forms include "Running record table" and "Form of sampling results".

.2 Assurance of indoor sample analysis quality

Experiment and analysis participants shall attend training before positioning in accordance with "SOU BWTL's personnel training program" and related testing standards, chemical test related personnel should receive training in chemical safety and protection, rescue knowledge. The key chemical testing participants (who are familiar with all kinds of testing methods, program, purpose and result evaluation) should well know the method to evaluate chemical analysis and measurement uncertainty. Biological experiment personnel should get familiar with biological testing safety operation knowledge and disinfection knowledge, to ensure that these personnel are qualified and subject to supervision, and they will work in accordance with the management system requirements.

In the testing process, the experiments and sample analysis shall be conducted in strict accordance with the prescribed procedures and operation requirements, and corresponding preparation shall be made in line with previsions in "Chemical reagent quality assurance", "Vessel quality assurance", "Instrument quality assurance", "Water chemical analysis process quality assurance" and "Laboratory detection method quality assurance".

All raw data must be recorded clearly, then stored and preserved in the devices that can protect the data from being damaged, deteriorated or lost, in the manner for easy fetch. The record storage period must be defined. The safety and confidentiality of all the records shall be ensured. The identification, indexing, access, filing, storage, maintenance and removal of technology record and quality control record shall be conducted according to the "SOU BWTL's record control program". The final forms include "Form of original record of phytoplankton test", "Form of original record of floating animal", "Form of original record of microbial detection" and "Form of original record of water parameter measurement".

.3 Testing, maintenance and calibration of measuring instruments and equipment

Instruments and equipment will be registered in "Instrument equipment list" by the equipment administrator, coupled with equipment files and corresponding identification. Only those testers who hold a Tester Certificate or those authorized can use the equipment and instruments, and they cannot actually implement the operation unless they are authorized by BWTL and record "Equipment and instrument utilization record" must be finished. The maintenance of instruments and equipment in use must be in the charge of a responsible person who then should make "Form of daily maintenance of instruments and equipment", and according to the items and period the users shall complete the maintenance and corresponding record.

The instruments and equipment that should be verified/calibrated by legal metrological verification authority should be scheduled for verification/calibration by laboratory manager in accordance with the "Traceability of values", in order to obtain the corresponding certificate. Usually, the instruments and equipment will be verified/calibrated once every 12 months, or once every six months if there are special needs.

.4 Assurance of data collection and management quality

The persons in charge of technology will summarize the field land-based test and indoor test results and organize data collection and statistics. The data of field test and sampling and those of the laboratory test shall be recorded in the waterproof record form, or electronic document of field sampling data shall be filed as soon as possible, and electronic data management shall accord with the "Laboratory computer management program". All of the test data records will be stored by the data administrator. The original test record and test report copy should be properly preserved for five years by the data manager with good security and confidentiality, without non-related persons' reference.

.5 Assurance of test report quality

The laboratory must accurately, clearly and objectively report each test or a series of test results, in accordance with corresponding provisions. Each of the test reports shall include the following information or more: test design, the identification of analysis method, state description and clear identification of tested objects, the received date of tested objects, test date, test results, test report approver or equivalent identification; when the test results shall be explained, the test report should also include the statement about deviation from detection method or evaluation of measurement uncertainty. The test results contained in test reports issued by subcontractors, if there are any, results must be clearly marked, and the subcontractor shall report the results in writing or electronic form.